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主 論 文 要 旨

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論文題名　NOVEL TRANSITION RADIATION LASER

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主論文要旨

The major aim of this work is to analyze a model of a transition radiation laser based on stimulated emission induced by relativistic electrons crossing the boundary between two media of different dielectric properties. The interaction between the incident radiation and the relativistic electrons in the boundary region of the two dielectric media leads to stimulated emission and absorption of radiation. We applied phenomenological quantum electrodynamics to derive analytical expressions for stimulated emission and absorption probabilities. We see that stimulated emission is greater than stimulated absorption so that there is a possibility of gain. We calculated the gain for a single interface. We also calculated the gain for a single foil which has two interfaces. The expression for single foil gain shows some resonant effect. The gain in this case is further increased when some resonant condition is met. As a way of increasing the gain significantly, we propose the existence of coherent gain when the electron beams are pre-bunched such that the bunch length is comparable or less than the wavelength of the radiation. In order to show, in a fundamental way, the similarity between the basis of this laser and that of classical lasers, we derived and discussed analogs of Einstein's coefficients for the transition processes.

. Our laser concept is fundamentally different from RTR laser analyzed in literature. The RTR laser is similar to conventional FEL, thus the micro bunching process of electron beam is taken into accounts. The laser we analyzed here is in some way similar to classical lasers except that free relativistic electrons are involved, but the micro bunching process is unnecessary. The operation of the laser requires successive overlap of the electron bunches and the radiation at the boundaries of the dielectric media. This overlap requires a matching condition. The condition for this matching has been derived